TRANSMITTING DEVICE OF THREE DIMENSIONAL SHAPE

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Abstract

PURPOSE:To obtain the information of an article rapidly and precisely by transmitting laminated information for the shape and color of the article obtained by moving a center direction distance sensor horizontally and vertically through a communication circuit and synthesizing signals received in each layer on the receiving side.
CONSTITUTION:The article 1 is set up on a horizontal board and a board mounting a measuring sensor 5 and color sensor 6 is rotated around the Z axis by a motor 8. The length between the sensor 5 and the surface of the article is measured by the sensor 5 in each rotation and the color is detected by the color sensor 6. Then, the board 4 is finely moved by a motor 10 in the Z axis direction along a pole 9. An external shape coordinate finding circuit 15 finds out the shape and color information on the basis of inputs from the sensors 5, 6 and positional signals from the motors 8, 10 and sends the obtained information to the communication circuit 20. On the receiving side, a molding machine is controlled on the basis of the sent signal, photosensitive resin is applied to each layer, exposed, hardened, and colored. Then the resin on an unexposed part is removed. Consequently, the shape and color of the article can be transmitted rapidly and precisely to a remote place.

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PATENT APPLICATION

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CLAIMS

1 A device for transmitting three-dimensional shapes characterized by an information transmitting system which links a transmitter and a receiver by communications lines, where the transmitter is equipped with a distance measuring sensor (hereafter referred to as the sensor) installed above the {ILLEGIBLE} ~~a~~ plate-shaped sensor rotating system which rotates said sensor horizontally at fixed angular increments on said {ILLEGIBLE}, ~~a~~ plate-shaped system sensor surface movement system which mose the horizontal rotation surface of the sensor up and down vertically, a sensor position/angle instruction circuit for the vertical movements and rotation position of said sensor, and a circuit for deducing the appearance coordinates of the object whose shape is to be transmitted (hereafter referred to as the "object") which is mounted near the center of the sensor's rotation, the coordinates of the object, measured as the sensor rotates around it in predetermined angular increments, are digitally encoded layer by layer as the sensor is moved upwards by predetermined increments, and where the receiver is comprised of a shaping apparatus equipped with a gun for spraying photo-sensitive resin agent (hereafter referred to as the photo-sensitive agent gun), a gun for spraying a light-reflecting agent (hereafter referred to as the reflecting agent gun), and an irradiating gun **[1b]** all mounted as a unit so as to be able to be moved into indicated positions along three-dimensional axes, and a gun switching/positioning instruction circuit for each gun, a layer-specific coordinate memory which stores the digital code sent from the aforementioned transmitter for each layer, and a region/non-region partitioning circuit which processes the coordinate data in the layer-specific memory circuit; the photo-sensitive agent is sprayed by the photo-sensitive agent gun to the thickness of the predetermined incremental motions of the aforementioned transmitter, the irradiating gun irradiates the region to be irradiated by light, hardening said photo-sensitive agent, while reflecting agent is sprayed onto the region not to be

irradiated by light is sprayed by the reflecting agent gun, and this is repeated layer by layer until finally the unradiated photo-sensitive agent is removed and a laminated model in the shape of the above-mentioned object is formed.

2 A device for transmitting three-dimensional shapes as described in Paragraph 1 of the Claims of this Patent Application characterized by the above-described transmitter being equipped with a mounting platform on which the object is mounted rotates horizontally instead of the horizontally rotating sensor as described above.

3 A device for transmitting three-dimensional shapes as described in Paragraph 1 of the Claims of this Patent Application such that the sensor described in Paragraph 1, the sensor rotating system, and the sensor surface motion system are able to move 90° [2a] such that the horizontally rotating surface of the sensor as described in Paragraph 1 can be a vertically rotating surface, and the vertical movement up and down can be converted into horizontal motion.

4 A device for transmitting three-dimensional shapes as described in Paragraph 1 of the Claims of this Patent Application such that the mounting platform and the system for rotating the mounting platform can be rotated 90° so that the horizontally rotating platform on which the object is mounted and which described in the foregoing Paragraph 2 of the Claims of this Patent Application can rotate vertically.

5 A device for transmitting three-dimensional shapes as described in Paragraph 1 of the Claims of this Patent Application characterized by incorporating into the transmitter a public domain computer for processing three dimensional designs and deducing the coordinates and colors of the object data created by said computer for processing three-dimensional designs as digital codes.

6 A device for transmitting three-dimensional shapes as described in Paragraphs 1 through 5 of the Claims of this Patent Application characterized by the ability to color the photo-sensitive agent by installing a color analyzer onto the transmitter described in Paragraphs 1 through 4 of the Claims of this Patent Application, which moves as a single

unit with the sensor, and by equipping the receiver described in Paragraphs 1 through 5 of the Claims of this Patent Application with a gun which sprays colorant (hereafter ref rred to as the colorant gun), and which moves as a single unit with the photo-sensitive agent gun, so that the transmitter transmits the color of the object encoded digitally along with the coordinates, and the receiver receives this and colors the photo-sensitive agent by said colorant gun as the photo-sensitive agent is sprayed.

7 A device for transmitting three-dimensional shapes as described in Paragraphs 1 through 6 of the Claims of this Patent Application characterized by the incorporation of an enlargement/reduction circuit in the region/non-region partitioning circuit of the receiver so that enlarged and reduced shapes can be formed.

DETAILED EXPLANATION OF THE INVENTION

Industrial Applications

This invention concerns a device for transmitting three-dimensional shapes.by accurately and promptly sending the design, color, and shape of the object to a distant party.

Prior Art

Conventionally, when a distant party requests a test product, product sample, master pattern or mold, machine processed item, three-dimensional design, etc., the shape, appearance, and color of the object is transmitted to the distant client by shipping out the actual item itself, sending documents such as photographs, sketches, drawings, etc., or by transmitting facsimilies of these.

Problems to be Solved by This Invention

In the above-described conventional methods for transmitting the shape, appearance, and colors of an item, when drawings, sketches, or photographs are sent, there is the time loss of the time required to make the drawings and sketches or prepare the photographs and dispatch them which impares the prompt transmission of the information, nor do these methods address the problem of allowing the receiving party to actually understand and grasp the real shape, colors, and appearance of the item directly. When the item itself is sent, the time required for packaging and registering the item as well as the transit time impare the prompt transmission of the information, and this is particularly problematic when the receiving party is at a distant overseas location. Moreover, there always exists the risk of damage or loss occurring during transit when these methods are used.

In order to solve the problems described above, this invention takes as its object the offering of a device for transmitting three-dimensional shapes which promptly, accurately, and reliably transmits to the second party the shape, colors, and appearance of the item in question.

Methods Employed to Solve the Problems

This invention is characterized by a solution to the above described problems which, as a method for measuring the shape, appearance, and color of the object, uses first a transmitter which is equipped with a sensor and color analyzer revolving horizontally as one unit, and which is equipped with a sensor rotating system constituted so the surface of rotation can be moved up and down, and a sensor surface moving system, as well as sensor position/angle instruction circuits and appearance coordinate

deduction circuits; as a method of making a three-dimensional shape of the object for the benefit of a distant party it uses a receiver comprised of a shaping apparatus equipped with a photo-sensitive agent gun, a colorant gun, a reflective agent gun, and an irradiating gun, constituted so as to move along three-dimensional axes as one unit, as well as a layer-specific coordinate memory, a region/non-region partitioning circuit, and gun switching/positioning circuits; as a method of communicating from the above-described transmitter to the receiver, it is constituted so as to transmit digitally encoded information indicating the shape and color of the object. In addition, as a method of analyzing hidden apertures in the object, the transmittor is capable of rotating the sensor rotating system and the senson surface movement system 90° so that the sensor rotation system is vertical.

Moreover, as a variant embodiment of the above, instead of rotating the sensor and color analyzer of the transmitter as [3a] described above, a method which rotates the body itself is incorporated by installing a mounting platform rotation system. In this case, the device is constituted to allow the rotation surface of said mounting platform rotation system to be set at a 90° angle as a method of analyzing hidden apertures.

Moreover, in another embodiment, the transmitter uses the shape and color data directly from a public domain computer which processes three-dimensional designs instead of recognizing the shape and color from an object, and is constituted so as to include circuitry for deducing appearance coordinates as a method of processing said data.

Also, circuitry for computing enlargements and reductions is incorporated in the region/non-region partitioning circuits in the receiver as a method of forming enlarged or reduced models.

Function

This invention uses a process for modeling objects by accumulating layers of a predetermined thickness which have been hardened and shaped from a liquid resin agent which has the characteristic of being sensitive to and hardening by ultraviolet light, etc., (hereafter indicated as 'the above-described photo-sansitive agent"), and in order to color the modeled object, mixes in a colorant while the photo-sensitive agent is still in a liquid form, and is thus able to transmit the shape and color of the object to a distant location [3b].

The transmitter has the function of comprehending the shape and color of the object in layers, deduces the appearance coordinates of the object layer by layer, separates out the color for each set of coordinates, and digitally encodes the information; the receiver has the function of forming a model of the object based on said digital code transmitted by a method of communication, and after it has interpreted the digital code for each layer and processed the calculations for hidden apertures, it controls the shaping process and makes a model of the object as described above.

Examples

The following explains an embodiment of the invention in detail using the diagrams.

First the constitution is explained. **Figure 1** is a diagram showing the constitution of the Transmitter for the invented device for forming three-dimensional shapes, and **Figure 2** is a diagram shwoing the constitution of the Receiver for the same. The Mounting Platform 2 on which the Object 1 whose shape and color are to be transmitted

is mounted is fixed in approximately the center [CHECK ORIGINAL] of the Transmitter by the Supporting Arm **3** at the [ILLEG.] (emplacer) (not shown in the diagram). Around the periphery of said Mounting Platform **2** the Sensor Platform **4** revolves horizontally around the central vertical axis of the Mounting Platform **2**, and the Sensor **5** which measures distance and faces the center, and the Color Analyzer **6** which, like Sensor **5**, faces the center of the horizontal surface, are installed [?] on said Sensor Platform **4**. Sensor Platform **4** is supported on the Platform for Moving the Sensor Surface **7** which is capable of horizontal movement, and is positioned by a Motor for Rotating the Sensor **8** which is a servo-motor, pulse motor, or similar motot (hereafter "servo-motor" will be used to represent the range of possible motors). For said Sensor Moving Platform **7** to be capable of vertical movement, a number of Poles **9** support the Sensor Moving Platform **7** so that it can be driven by the Motor for Moving the Sensor Surface **10**, which is a servo-motor or the equivalent. The Frame **11**, in which the Poles **9** and the Sensor Surface Moving Motor **10** are installed, is driven by the Motor for Rotating the Sensor Surface Vertically **12**, a servo-motor or the equivalent, supported by an [redacted] (emplacer) (not shown in the diagram) able to rotate 90 degrees in the horizontal plane arount the vertical axis (hereafter referred to as the Z axis) running through the aforementioned Mounting Platform **2**. Sensor **5** employs a laser or other distance measuring apparatus, using a laser source, splitter, fixed reflectors, phototransistors, and other components which are in the public domain. The Color Analyzer **6** also uses components such as a prism spectroscope, phototransistor, etc. **[3d]** The Motor for Rotating the Sensor **8** and the Sensor Platform **4** are one embodiment of the Sensor Rotating System, and the Platform for Moving the Sensor Surface **7**, the Poles **9**, and the Motor for Moving the Sensor Surface **10** are an embodiment of the Sensor Surface Moving System.

The circuitry for the Transmitter is also shown in **Figure 1**. The Circuit for Detecting the Quantity of Light **6a** is connected to the Color Analyzer **6** so as to receive signals of the three primary colors, and the Circuit for Computing Measurement **5a** is

connected so as to receive the laser interference light signals of the Sensor 5. Each motor 8, 10, and 12, is constructed so as to be connected to the corresponding Movement Circuit 8a, 10a, or 12a, and to revolve forwards or backwards by only the amount instructed by the movement signals received from these circuits. Said Movement Control Circuits 8a, 10a, and 12a are connected with the Sensor Angle/Position Instruction Circuit 13; Movement Control Circuits 8a and 12a receive angle instruction signals, and Movement Control Circuit 10a receives position instruction signals. The Appearance Coordinate Detector Circuit 14 is connected such that it receives measurement computation values from the Measurement Computing Circuit 5a, values of the quantity of light in three primary colors from the Circuit for Detecting the Quantity of Light 6a, and Sensor position and angle change signals from the Sensor Angle/Position Instruction Circuit 13, and is constructed and connected so that it outputs digital signals which indicate the Object's appearance and coordinates to the Line Interface Circuit 15 [4a]. The Line Interface Circuit 15 changes said digital signals to serial signals and is connected to the Communications Circuit 20 either directly or through a public line by [ILLEGIBLE=modem?].

In this invention, the Shaping Apparatus is the essential component of the Receiver; **Figure 2** is a summary diagram of this apparatus and **Figure 3** shows a view from above. In the Shaping Apparatus are installed the Poles **21a** and **21b** parallel to the X-axis and the Pole 22 parallel to the Y axis in the horizontal direction, and Poles **23a, 23b, 23c**, and **23d** parallel to the Z-axis in the vertical direction, where X, Y, and Z form a three-dimensional set of axes intersecting each other at right angles; the Y-axis Pole 22 has the X-axis motor 24, which is a servo-motor or the equivalent, positioned at its end and supported by the X-axis poles **21a** and **21b** such that it is able to move parallel to the X direction. The X-axis poles **21a** and **21b** have the Z-axis motor 25, which is a servo-motor or the equivalent, positioned at their ends and supported by the Z-axis poles 23a, 23b, 23c, and 23d such that they are able to move parallel to the vertical

direction. The Photo-sensitive Agent Gun 27, Light Irradiating Gun 28, Reflecting Agent Gun 29, Primary Color Colorant Gun 30, as well as the Photo-Sensitive Agent Container 31, Reflecting Agent Container 32, and each Colorant Container 33 are all installed on the Y-axis Poie 22 so that they are moved as a unit by the Y-axis Motor 26, which is a servo-motor or the equivalent. Each Container, 31, 32, and 33, can also be connected to each type of gun by a [ILLEGIBLE=flexible?] pipe which attaches to the outside of the containers. At the lower middle of the Shaping Apparatus is placed a Shaping Vessel 34 which is open on the top, such that each gun can move to its indicated position above the open surface, and sealed on the bottom, where there is emplaced the Plug for Removing Liquid Agents 34a. Each gun 27, 28, 29, and 30 is capable of a switching operation by its respective solenoid [?] (not shown in the diagram).

The circuitry of the Receiver is shwon in Figure 2. The construction and connections of the Line Interface Circuit are such that it receives digital signals form the above-described Transmitter from the Communications Circuit 20 and outputs said digital signals to the Memory Control Circuit 35. Said Memory Control Circuit 36 is in turn connected to the Layer-Specific Coordinate Memory 37, and is constituted so as to be able to command that data, such as the shaping coordinates or color, be written onto or read from the designated memory references. Said Layer-Specific Coordinate Memory 37 [4c] is connected to the Region/Non-Region Partitioning Circuit 38 and constituted so as to be able to receive both read-out and write-in data. Said Region/Non-Region Partitioning Circuit 38 is connected to the Gun Switching/Positioning Instruction Circuit 39 and constructed so as to receive sequence instruction signals and compute motion regions for each gun and output regional partitioning signals. As an auxilliary, the Enlargement/Reduction Circuit 41 is incorporated in said Region/Non-Region Partitioning Circuit. The Gun Switching/Positioning Instruction Circuit 39 is constructed and connected such that it receives the completed transmission signals from the Line Interface Circuit 35, determines the shaping sequence, outputs gun instruction signals to the Gun

Stop/Start Drive Circuit 40, and outputs position instruction signals to Motor Drive Circuit 24a, 25a, and 26a. Each Motor Drive Circuit is connected to a motor, 24a to the X-axis Motor 24, 25a to the Z-axis Motor 25, and 26a to the Y-axis Motor 26, and controls each motor, positioning it at the designated position.

The following describes the operation of a device for transmitting three-dimensional shapes having the constitution described above. First, the three-dimensional axes, the X and Y axes on the horizontal and the Z axis on the vertical, which are mutually perpendicular, are [4d] established with the point of origin at the center of the rotation of Sensor 5. Sensor 5 is sequentially moved by a fixed angular amount $\Delta\theta$ by the Sensor Angle/Position Instruction Circuit, when it has made one complete revolution it is moved upwards along the Z-axis by a fixed increment ΔZ and executes a rotation as before.

Meanwhile at every movement of $\Delta\theta$ the distance between the surface of the Object to the Sensor 5 is calculated by the Sensor 5 and the Distance Calculation Circuit 13, and by the formula given below, the Appearance Coordinates Detector Circuit deduces the coordinates of the Object's external shape. *R* is the distance from the center to the Sensor 5 (sensor rotation radius), *m* is the number of minute angular movements in one rotation, and *n* is the number of rotations by minute movements up the Z-axis.

$$Z = n \times \Delta Z$$

$$X = (R - L) \times \cos (m \times \Delta\theta)$$

$$Y = (R - L) \times \sin (m \times \Delta\theta)$$

The color at said X, Y, and Z coordinates can be measured immediately before or after the sampling point of the fixed angle Δa by the Color Analyzer 6 and the Circuit for Detecting the Quantity of Light 6a, so the Appearance Coordinates Detection Circuit 14 holds both the distance and color analysis data for each sampling point until completion of the sampling process, assigning appropriate colors to the coordinates [5a].

By not changing the Z-axis until the angles have made a circuit as above the Object is comprehended as though it is divided into layers along the Z-axis. The coordinates and

colors thus apprehended are digitally codified into binary or other codes and, through the agency of the Line Interface Circuit 15, transmitted by the Communications Circuit to a Receiver in a distant location either as the generated data becomes available or as a batch stored in memory. Moreover, when there exists a Hidden Aperture such as 1a on the Object 1, the Motor for Moving the Sensor Surface Vertically 12 is moved by the Sensor Angle/Position Instruction Circuit 13 and Drive Circuit 12a so that the face of the S nsor rotation is vertical, and the Sensor is moved by a minute angular increment, $\Delta\theta$, at a time, over the vertical face comprised of the Y and Z axes, and when it has completed one rotation it is moved along the X axis by an increment limited to ΔX as described above, until the appearance and color of the object have been apprehended. The data thus derived are transmitted to the Receiver as movement data.

When the data arrives at the Receiver, it Line Interface Circuit 35 receives the digital code sent over the Communications Circuit 20 and through the agency of the Memory Control Circuit 36, it [5b] is stored in the Layer-Specific Coordinate Memory 37 for each layer along the Z-axis. When there is supplemental data the Region/Non-Region Partitioning Circuit 30 will correct the coordinates and add the position of the Hidden Aperture to the Layer-Specific Coordinate Memory 37. The corrections and updating for such hidden aperture processing may occur in the Transmitter as well. Upon completion of reception, the information is sent from the Line Interface Circuit 35 to the Gun Switching/Positioning Instruction Circuit 39, and said Circuit 39 initiates the shaping sequence operation. First the Photo-sensitive Agent 31a is sprayed over one surface in the Shaping Vessel 34 by the Photo-sensitive Agent Gun to a thickness $\Delta\theta$ which is the predetermined amount of movement of the above-described Transmitter. Meanwhile, from the Layer-Specific Coordinate Memory 37 the Gun Switching/Positioning Instruction Circuit 39 computes the amount of colorant from the three primary colors to be sprayed (by indicating the length of time for which valves are open, etc.) and also computes the spraying movement position of the Colorant Gun in the Region/Non-Region Partitioning

Circuit 38, executing the coloring operation once the photo-sensitive operation is complete. Similarly, it calculates the irradiation motion regions of the Light Irradiating Gun 28 between coloring operations, executing the light irradiating operation after the coloring operation is completed. The spray movement region of the Reflecting Agent Spray Gun 29 between executions of the light irradiation operation is similarly calculated and after the light irradiation operation [5c] has been completed, the reflective agent spraying operation is executed. The portions of said photo-sensitive agent 31a which have been irradiated by light harden to form a single layer. This is repeated until finally all the layers have accumulated to form a model which has the shape and color of the original Object. It is also possible at this point to form an enlarged or reduced model by enlarging or reducing the coordinates for the regions and non-regions by the Enlargement/Reduction Circuit 41. The reflecting agent is necessary for hardening to occur by irradiation wherever the Object has indentations. At the end of this process the Plug for Removing Liquid Agents 34a is opened to eliminate unhardened photo-sensitive liquid.

Figures 4 and 5 show other embodiments of the Transmitter of the invented device for transmitting three-dimensional shapes. In Figure 4 the Sensor 5 is only able to move vertically but the Mounting Platform 2 is moved horizontally by the Motor for Rotating the Mounting Platform 16, allowing a similar deduction of coordinates. It is constructed so that the Motor for Switching the Mounting Platform 17 switches 90° so it can revolve vertically in order to measure the Hidden Aperture 1a. In order that the Object does not fall off the stand in such cases [5d] it is held to a transparent ring (not shown in the diagram) by pins or the equivalent, supported at many points, arranged so that when the coordinates are deduced such objects extraneous to the Object such as said pins or transparent ring are ignored. Figure 5 shows the transmission of three-dimensional data created by a public domain Computer which Processes Three-dimensional Designs 18; by the Appearance Coordinate Detector Circuit 14, it hypothesizes three-dimensional axes based on said object data, deduces the color and

coordinates of the Object layer by layer, and encodes them digitally. In this case it is possible to use a short cable, etc., and incorporate the Communications Line 20 as part of the Computer which Processes Three-dimensional Designs 18.

Effects of the Invention

When the invented device for transmitting three-dimensional shapes is used to transmit the color and shape of an object to a party in a distant location, the actual object can be modelled in the new location without relying on documents such as drawings, photographs, or sketches, therefore it is accurate; because there is no time lost to shipping or mailing and since the time needed to make drawings, photographs, and sketches is eliminated, it is prompt; and because there is no risk of loss or damage in transit, it is reliable. For the above-described reasons, this invention is [6a] an effective method of sending the shape and color of an object accurately, promptly, and reliably to a distant party.

In the modern social and business environment [ILLEGIBLE] which continually redefine expectations of accuracy and promptness, this invention has the effect of producing increased time effectiveness and profitability by increasing the share of a produce and bestowing an advantage over the competing companies.

Also, since the data necessary to form the model is stored in the Layer-Specific Coordinate Memory of the Receiver, it is possible to produce identical models or, by an operation of the Enlargement/Reduction Computing Circuit, to produce enlarged or reduced models extending the effectiveness of shape and color transmission over a wide range of applications.

BRIEF EXPLANATION OF THE DIAGRAMS

Figure 1 through 3 show diagrams of an embodiment of this invention, and Figures 4 through 5 show other enbodiments. Figure 1 is a diagram summarizing the constitution of the transmitter for the invented device for forming three-dimensional shapes, viewed obliquely, and its constituent circuits. Figure 2 is a diagram summarizing the shaping apparatus of the receiver of this invention, viewed obliquely, and its constituent circuits. Figure 3 is a surface diagram of said shaping apparatus. Figure 4 shows another embodiment of the transmitter of the invented device for transmitting and shaping three-dimensional objects. Figure 5 shows the constitution of yet another embodiment of the transmitter.

1 Object

2 Mounting Platform

3 Support Arm

4 Sensor Platform

5 Sensor

5a Measurement Computing Circuit

6 Color Analyzer

6a Circuit for Detecting the Quantity of Light

7 Platform for Moving Sensor Surface

8 Motor for Rotating Sensor

9 Poles

10 Motor for Moving Sensor Surface

11 Frame

12 Motor for Switching Sensor Surface Vertically

13 Sensor Angle/Position Instruction Circuit

14 Appearance Coordinate Detector Circuit

15 Line Interface Circuit

16 Motor for Rotating Mounting Platform

17 Motor for Switching the Mounting Platform

18 Computer which Processes Three-dimensional Designs

20 Communications Circuit

21a, 21 b Poles for X-axis

22 Poles for Y-axis

23a, 23b, 23c, 23d Poles for Z-axis

24 X Axes Motor

[24a Motor Drive Circuit]

25 Z Axes Motor

[25a Motor Drive Circuit]

26 Y Axes Motor

[26a Motor Drive Circuit]

[26a Motor Drive Circuit]

27 Photo-sensitive Agent Gun

28 Light Irradiating Gun

29 Reflecting Agent Gun

30 Primary Color Colorant Gun

[31 Light Sensitive Agent Container

32 Reflecting Agent Container

33 Colorant Containers for each Color]

34 Shaping Vessel

[34a Plug for Removing Liquid Agents]

35 Line Interface Circuit

36 Memory Control Circuit

37 Layer-Specific Coordinate Memory

38 Regional/Non-Regional Partitioning Circuit

39 Gun Switching/Positioning Instruction Circuit

40 Gun Stop/Start Drive Circuit

[41 Enlargement/Reduction Circuit]

⑲日本国特許庁(JP)　⑪特許出願公開

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⑤4発明の名称　三次元形状伝送装置

⑳特　願　昭59－210074

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明　細　書

1. 発明の名称

三次元形状伝送装置

2. 特許請求の範囲

(1) 発信装置と受信装置を公社回線等の通信回線で接続した情報伝送装置において、発信装置は中心から一定距離の円周上に設けた中心方向距離センサー（以下センサーと記す）と該センサーを前記円周上を指定角度に水平回動させるセンサー回動機構とセンサーの水平回動面を指定位置に垂直上下動させるセンサー面移動機構と該センサーの回動位置及び上下動位置のセンサー位置・角度指定回路とセンサー回動の中心付近に載置した形状伝送対象物体（以下物体と記す）の外形座標割出回路とを備えセンサーを一定微動量上動させて一定微角度ずつ一周回動させ該一定微角度動くごとに物体の座標を積層的にデジタル符号として割出すようにし、また受信装置は三次元軸を有して指定位置に移動可能な感光硬化性樹脂剤塗布ガン（以下感光剤ガンと記す）と光反射剤塗布ガン（以下反射剤ガンと記す）と光照射ガンとを一体的に備えた成形機と上記各種ガンのガン切替・位置指定回路と前記発信装置から伝送されるデジタル符号を各層毎に記憶する層別座標メモリーと該層別座標メモリーの座標データを処理する領域・領域外区分回路とを備え前記発信装置の一定微動量の厚みに感光剤ガンで感光剤を塗布し光照射領域には光照射ガンで光を照射して該感光剤を硬化させ光照射領域外には反射剤ガンで反射剤を塗布しこれを層毎に行い最後に非照射感光剤を除去して前記物体の形状を積層成形させるように構成したことを特徴とする三次元形状伝送装置。

(2) 前記発信装置のセンサーは水平面を回動せず代りに物体載置台を水平回動するように載置台回動機構を設けたことを特徴とする前記特許請求の範囲第1項記載の三次元形状伝送装置。

(3) 前記特許請求の範囲第1項記載のセンサーの水平回動面を垂直回動面とし垂直上下動を水平動と成すこともできるよう該センサーおよびセンサー回動機構およびセンサー面移動機構を90度回

動可能とした特許請求の範囲第1項記載の三次元形状伝送装置。

(4) 前記特許請求の範囲第2項記載の水平回動する物体載置台を垂直回動できるように載置台および載置台回動機構を90度回動可能とした特許請求の範囲第2項記載の三次元形状伝送装置。

(5) 発信装置は公知の三次元図形処理コンピュータに外形座標割出回路を付加して該三次元図形処理コンピュータの作成した物体データの座標ないし色を積層的にデジタル符号として割り出すようにしたことを特徴とする前記特許請求の範囲第1項記載の三次元形状伝送装置。

(6) 前記特許請求の範囲第1項ないし第4項の発信装置にはセンサーと一体的に移動する物体色分析器を設け特許請求の範囲第1項ないし第5項の受信装置の成形機には感光剤ガン等と一体的に移動する着色剤塗付ガン（以下着色剤ガンと記す）を備え発信装置は座標とともに物体色をデジタル符号化して伝達しこれを受けて受信装置は感光剤塗付後に該着色剤ガンで感光剤に着色できるようにしたことを特徴とする前記特許請求の範囲第1項ないし第5項までのいずれかに記載の三次元形状伝送装置。

(7) 受信装置は拡大・縮少演算回路を領域・領域該区分回路に付加し拡大成形・縮少成形も可能としたことを特徴とする前記特許請求の範囲第1項ないし第6項までのいずれかに記載の三次元形状伝送装置。

3. 発明の詳細な説明

〔産業上の利用分野〕

本発明は立体的なデザイン・物品の形状・色を遠隔地の相手方へ正確・迅速に伝える三次元形状伝送装置に関する。

〔従来の技術〕

遠隔地の相手方に対し試作品，見本品，成形型材，切削加工物，立体デザイン物などの確認を求める場合、従来は実物の輸送や写真，スケッチ，図面等の書類の郵送またはファクシミリによる伝送によって相手方にそれらの物品の形状や外観や色などを伝えていた。

〔発明が解決しようとする問題点〕

前記のような従来の物品の形状・外観・色の伝達手段において図面やスケッチや写真の送達による場合、図面やスケッチを作成する時間、写真を調整する時間、郵送に要する時間などの時間損失が迅速に伝達する上で障害となっており、また相手方では物品の形状・外観・色を実物に即して実感的に理解・把握するのが困難であるなどの問題点があった。また実物の輸送による場合においては輸送の梱包・手続きに要する時間や輸送時間が前記同様迅速さの障害となり特に遠隔地が海外である場合には顕著であった。さらに輸送においては常に破壊や紛失の危険性がつきまとうのも問題であった。

本発明は上記問題点を解決するためになされたもので物品の形状・外観・色を迅速・正確・確実に相手方に立体成形物として伝達する三次元形状伝送装置を提供するのを目的としている。

〔問題点を解決するための手段〕

本発明は上記問題点を解決するためまず物品の形状・外観・色を認識する手段としてセンサーと物体色分析器とを備えて一体的に水平回動しその水平回動面を上下動できるように構成したセンサー回動機構とセンサー面移動機構ならびにセンサー位置・角度指定回路と外形座標割出回路とを備えた発信装置を設け、遠隔地の相手方において立体成形物を作成する手段として感光剤ガン・着色剤ガン・反射剤ガン・光照射ガンを備えこれらを一体的に三次元軸を移動できるよう構成した成形機と層別座標メモリーと領域・領域外区分回路とガン切替・位置指定回路とを備えた受信装置を設け前記発信装置から受信装置へ通信手段で物体の形状・色を示すデジタル符号情報を伝達するよう構成したことを特徴としている。なお物体の上下にある隠れた穴を解析し付加する手段として発信装置のセンサー回動機構とセンサー面移動機構とをセンサー回動面が垂直となるように90度回動可能としている。

さらに以上の他の実施態様として発信装置のセンサーおよび物体色分析器を前述のように回動す

る代りに物体側を回動させるようにしこの手段としては物体の載置台回動機構を設けた構成とすることができる。この場合、隠れ穴を解析する手段としては該載置台回動機構の回動面が垂直となるように９０度回動できる構成とする。

また他の実施態様として発信装置が直接に物体の外形・色を認識する代りに公知の三次元図形処理コンピュータの外形や色のデータを利用し該データを処理する手段として外形座標割出回路を付加した構成とすることもできる。

さらに受信装置において拡大成形・縮少成形する場合の手段としては領域・領域外区分回路に拡大・縮少演算回路を付加している。

〔作　用〕

本発明は通常は液状であって紫外線等に感光すると硬化する性質を有する樹脂剤（前記感光剤を指す）により、一定の厚みずつ硬化成形してゆくと積層的に物体を模写成形できることを利用し、また感光剤が硬化成形前の液状のときに着色剤を塗付し混入すれば成形品に着色できることを利用して遠隔地に物体の形状と色を成形品として伝送しようとするものである。

発信装置は物体の色と外形を積層的に把握する機能を持ち各層毎の物体の外形座標を積層的に割り出しその座標の色を識別してデジタル符号化するよう作用し、受信装置は通信手段によって伝送された該デジタル符号をもとに物体を模写成形する機能を持ちデジタル符号を各層毎に記憶し隠れ穴等を演算処理した後成形機を制御して物体を前述の如く模写成形するよう作用する。

〔実施例〕

本発明の実施例を図面に基ずいて詳細に説明する。

まず構成について説明する。第１図は本発明の三次元形状伝送装置の発信装置を示す構成図、第２図は同受信装置を示す構成図である。発信装置の略中央に形状・色を伝送したい物体１を載置する載置台２を支持脚３などで筐体（図示せず）に固定する。該載置台２の周囲には載置台２の中央垂直軸を中心として水平回動するセンサー台４を配設し該センサー台４上に中心に向って距離を測定するセンサー５と該センサー５と同一水平面上にあって同様に中心方向に向う物体色分析器６とを併設する。センサー台４はセンサー面移動台７に水平回動可能に保持され、サーボモータまたはパルスモーター（以下代表してサーボモータと記述する）などのセンサー回動用モーター８により駆動される。該センサー面移動台７は垂直方向に移動可能なように例えば複数本のポール９で支えられ、サーボモーターなどのセンサー面移動用モーター１０により駆動される。ポール９およびセンサー面移動用モータ１０を固定するフレーム１１は前記載置台２の垂直中心軸（以下Ｚ軸と記す）と交わる水平軸を中心に９０度回動可能に筐体（図示せず）に軸支されサーボモータなどのセンサー面垂直転換用モーター１２により駆動される。センサー５はレーザー発光器，スプリッタ，固定反射鏡，フォトトランジスタなどの公知のレーザー測長器などが使用される。また物体色分析器６はプリズム分光器，フォトトランジスタ等が，使用される。センサー回動用モーター８およびセンサー台４はセンサー回動機構の一例であり、センサー面移動台７，ポール９，センサー面移動用モーター１０はセンサー面移動機構の一例である。

発信装置の回路機構は同じく第１図に示されている。光量検出回路６ａは物体色分析器６から三原色分光信号を受信するよう接続され、測長計数回路５ａはセンサー５のレーザー干渉光信号を受信するよう接続されている。各モーター８，１０，１２は各々駆動回路８ａ，１０ａ，１２ａに対応して接続され駆動信号を受信して指定量だけ正・逆転するよう構成されている。該駆動回路８ａ，１０ａ，１２ａにはセンサー角度・位置指定回路１３と接続され駆動回路８ａ，１２ａは角度指定信号を、駆動回路１０ａは位置指定信号を受信する。外形座標割出回路１４は測長計数回路５ａから測長計数値を、光量検出回路６ａから三原色光量値を、センサー角度・位置指定回路１３からセンサー位置・角度変化信号を受信するよう接続され、回線インターフェース回路１５へ物体の外形

座標と色を示すデジタル符号を出力するよう接続され構成されている。回線インターフェース回路は該デジタル符号をシリアル信号化し直接または音声変調をかけて公社回線などの通信回線２０に接続される。

本発明の受信装置の要部である成形機は第２図に概略的側面図が、第３図にその上面図が示されている。成形機は互いに直交する三次元軸に添って水平方向のＸ軸ボール２１ａ，２１ｂ及びＹ軸ボール２２と垂直軸方向のＺ軸ボール２３ａ，２３ｂ，２３ｃ，２３ｄとが配置され、Ｙ軸ボール２２はその両端をＸ軸ボール２１ａ，２１ｂで支持されサーボモーター等のＸ軸モーター２４によりＸ方向へ平行移動可能に配設されている。該Ｘ軸ボール２１ａ，２１ｂは各両端がＺ軸ボール２３ａ，２３ｂ，２３ｃ，２３ｄに支持されサーボモーター等のＺ軸モータ２５により垂直に平行移動できるよう配設されている。Ｙ軸ボール２２には感光剤ガン２７と光照射ガン２８と反射剤ガン２９と三原色の着色剤ガン３０および感光剤容器３１と反射剤容器３２と各種着色剤容器３３などがサーボモーター等のＹ軸モーター２６により一体的に移動できるよう配設されている。各容器３１，３２，３３は外部へ配置し可撓性パイプで各種ガンへ接続しても良い。成形器中央下部には上面が開口し底部が閉じられ液剤抜取栓３４ａが付けられた成形容器３４が配置され、その開口面を各種ガンが指定位置に移動できるよう構成されている。各種ガン２７，２８，２９，３０は各々ソフノイドなど（図示せず）により切替作動可能となっている。

受信装置の回路構成は第２図に示されている。回線インターフェイス回路３５は通信回線２０に接続され前記発信装置のデジタル符号を受信しメモリー制御回路３６へ該デジタル符号を出力するよう接続・構成されている。該メモリー制御回路３６はさらに層別座標メモリー３７と接続され指定のメモリー番地に対し物体の外形座標や色などのデータの書き込みや読み出しを指令することができるよう構成されている。該層別座標メモリー３７は領域・領域外区分回路３８と接続され読み出しデータや書き込みデータの授受ができるよう構成され、該領域・領域外区分回路３８はガン切替・位置指定回路３９と接続されてシーケンス指示信号を受信し各種ガンの動作領域を演算して領域・領域外信号を出力するよう構成されている。また該領域・領域外区分回路には補助的に拡大・縮少回路４１が付加されている。ガン切替・位置指定回路３９は回線インターフェース回路３５から伝送終了信号を受けて成形動作シーケンスを決定しガン開閉駆動回路４０にガン指定信号を出力しモーター駆動回路２４ａ，２５ａ，２６ａに位置指定信号を出力できるよう接続され構成されている。各モータ駆動回路の２４ａはＸ軸モーター２４に、２５ａはＺ軸モーター２５に、２６ａはＹ軸モーター２６に各々接続され指定位置へ位置決めできるよう各モーターを制御する。

次に以上のように構成された三次元伝送装置の作動について説明する。まず発信装置においてセンサー５の回動面の中心を原点とし互いに直交する三次元軸である水平方向のＸ軸とＹ軸及び垂直方向のＺ軸を想定する。センサー５はセンサー角度・位置指定回路によりシーケンス的に一定微角度△θ毎に移動され一周回動すると一定微動量△ＺだけＺ軸方向へ移動されまた同様に一周回動される。この間△θの移動毎にセンサー５と測長計数回路１３とにより物体外周からセンサー５までの距離Ｌが計測され、外形座標割出回路１４は次式により物体外周の座標を割り出す。Ｒは中心からセンサー５までの距離（センサー回動半径），ｍは微角度移動回数，ｎはＺ軸微動量移動回数である。

$$Z = n \times \Delta Z$$

$$X = (R - L) \times \cos (m \times \Delta \theta)$$

$$Y = (R - L) \times \sin (m \times \Delta \theta)$$

このときの該座標Ｘ，Ｙ，Ｚの点の色は物体色分析器６と光量検出回路６ａにより一定角度θａで測長点より先または後に測定されるので外形座標割出回路１４は一つの測長点について測長と色分析の両方が終了するまで一方のデータを保持し座

標と色を対応づける。

以上のように角度が一周するまでZ軸は変化しないので物体はZ軸に対し層を成す如く把握される。この把握された座標と色はバイナリー符号などのようにデジタル符号化され回線インターフェース回路１５を介し通信回線２０により遠隔地の受信装置へ逐次または記憶させておいたものを一度に伝送する。なお物体１に１ａのような隠れ穴が存在する場合はセンサー回動面が垂直になるようセンサー面垂直転換要モーター１２をセンサー角度・位置指定回路１３と駆動回路１２ａにより駆動し、センサーをＹ軸とＺ軸とで構成される垂直面を△θづつ微角度回動させ一周したら△Ｘだけ Ｘ軸方向へ微動量移動させて前記同様にＸ軸に対し層を成す如く物体外形と色を把握する。こうしてできたデータは補助データとして前記同様に受信装置へ伝送される。

受信装置においては通信回線２０を通して送られたデジタル符号が回線インターフェース回路３５で受信されメモリー制御回路３６を介してＺ軸の各層毎に層別座標メモリー３７に記憶される。補助データがある場合は領域・領域外区分回路３８が層別座標メモリー３７に隠れ穴座標をＺ軸の各層毎に補正し付加する。なおこの隠れ穴処理は発信装置側にて補正・付加しても良い。こうして受信終了の通知が回線インターフェース回路３５からガン切替・位置指定回路３９に送出されると該回路３９は成形槽による成形シーケンス動作を開始させる。まず感光剤ガンにより成形容器３４内一面に前記発信装置の一定微動量△θの厚みに感光剤３１ａを塗付する。この間、ガン切替・位置指定回路３９は領域・領域外区分回路３８に着色剤ガン３０の塗付移動領域と三原色の各着色剤の塗付量（弁の開時間等）を層別座標メモリー３７のデーターから演算させておき、感光剤塗付動作が終了したら着色動作を実行させる。さらに着色動作の間光照射ガン２８の照射移動領域を同様に演算させ着色動作終了後に光照射動作を実行させる。また光照射動作実行の間反射剤塗付ガン２９の塗付移動領域を同様に演算させ光照射動作終了後に反射剤塗付動作を実行させる。該感光剤３１ａは光照射された部分が硬化し一つの層が成形される。これを繰り返し最終では積層的に物体の形状と色が模写成形される。ここで前記演算に際し拡大・縮少演算回路４１によって領域・領域外の座標を拡大または縮少させれば拡大成形または縮少成形が可能となる。また反射剤が必要なのは物体に窪みがある場合、そこに光が照射されて硬化しないようにするためである。こうして最後に溶液取出栓３４ａが開かれ硬化していない感光剤を抜き取って完了する。

なお第４図，第５図は本発明の三次元形状伝送装置の発信装置の他の実施例を示したもので第４図ではセンサー５は垂直方向にだけ移動するようにし、載置台２を載置台回動用モーター１６により水平回動させるようにして同じく座標割出を行なうようにしたものである。この場合、隠れ穴１ａに対応するために載置台面垂直転換用モーター１７により９０度転換して載置台２が垂直面を回動できるようになっている。この場合物体が落下しないようピンのようなもので透明球体（図示せず）などの多方面から保持し物体の座標を割出す際に物体以外の該ピンや透明球体などを無視するよう構成し作動させる。第５図では公知の三次元図形処理コンピューター１８の作成した物体データを伝送するもので外形座標割出回路１４によって該物体データをもとに３次元軸を想定して物体の座標と色を積層的に割り出しデジタル符号化するものである。この場合通信回線２０は短いケーブル等を使用し該三次元図形処理コンピューター１８のシステムの1部とすることも可能である。

〔発明の効果〕

本発明の三次元形状伝送装置によれば遠隔地にあって相手に物品の形状や色を伝えたい場合、その伝達方法は図面，写真，スケッチなどの種類にたよることなく実物を模写成形するので正確であり、図面，写真，スケッチなどの作成時間や調整時間が不要でかつ輸送や郵送のための時間損失もないので迅速であり、物品を輸送しないので紛失の恐れがなく確実である。以上のように本発明は

物品の形状や色を正確・迅速・確実に遠隔地の相手に伝える効果が得られる。

このことは正確・迅速化の要求される今日の国際化し情報化する企業競争社会にあって他社との競争に勝利し製品のシェアを拡大するなど多大の時間的効果や利益を生み出す効果を持たらすものである。

また受信装置の層別座標メモリーに成形動作に必要なデータが記憶されるので繰り返し同一の成形物を形成することも可能であり、拡大・縮少演算回路を作動させれば拡大成形あるいは縮少成形することも可能なので応用範囲の広い形状・色の伝達ができる効果が得られる。

4. 図面の簡単な説明

第1図ないし第3図は本発明の一実施例を示す図であり、第4図，第5図は他の実施例を示す図である。第1図は本発明の三次元形状装置の発信装置の概略的構成を示す斜視図とその回路構成を示す図、第2図は同受信装置の成形機の概略的構成を示す側面図と受信装置の回路構成を示す図、第3図は該成形機の上面図、第4図は本発明の三次元形状伝送装置の発信装置の他の実施例を示す斜視図、第5図は同発信装置のさらに他の実施例を示す構成図である。

1…物　体　　2…載置台
3…支持脚　　4…センサー台
5…センサー　　6…物体色分析器
5a…測長形数回路　6a…光量検出回路
7…センサー面移動台
8…センサー回動用モーター
9…ボール　　10…センサー面移動用モーター
11…フレーム
12…センサー面垂直転換用モーター
13…センサー角度・位置指定回路
14…外形座標割出回路
15…回線インターフェイス回路
16…載置台回動用モーター
17…載置台面垂直転換用モーター
18…三次元図形処理コンピューター
20…通信回路
21a，21b …X軸ボール　　22…Y軸ボール
23a，23b，23c，23d …Z軸ボール
24…X軸モーター　　25…Z軸モーター
26…Y軸モーター　　27…感光剤ガン
28…光照射ガン　　29…反射剤ガン
30…着色剤ガン　　34…成形容器
35…回線インターフェイス回路
36…メモリー制御回路
37…層別座標メモリー
38…領域・領域外区分回路
39…ガン切替・位置指定回路
40…ガン開閉駆動回路

特許出願人　新井容徳
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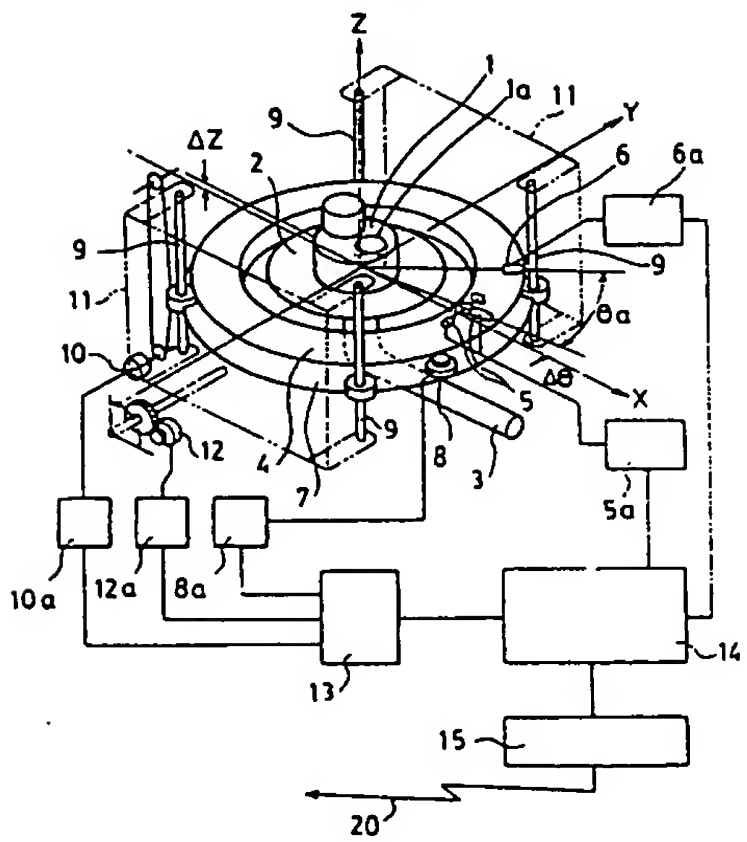
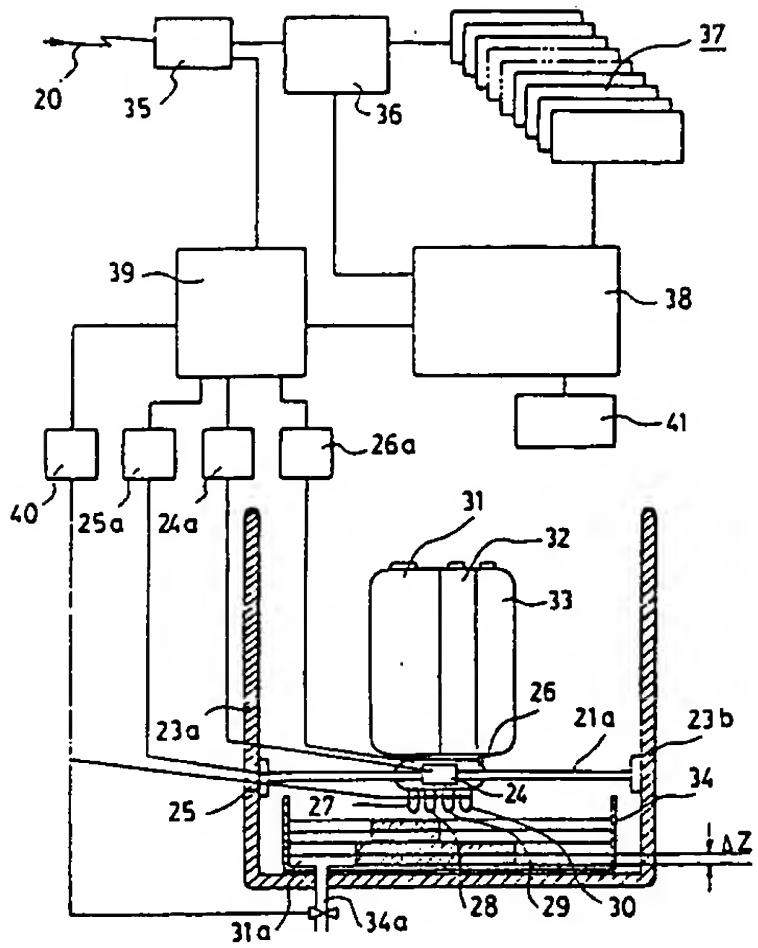
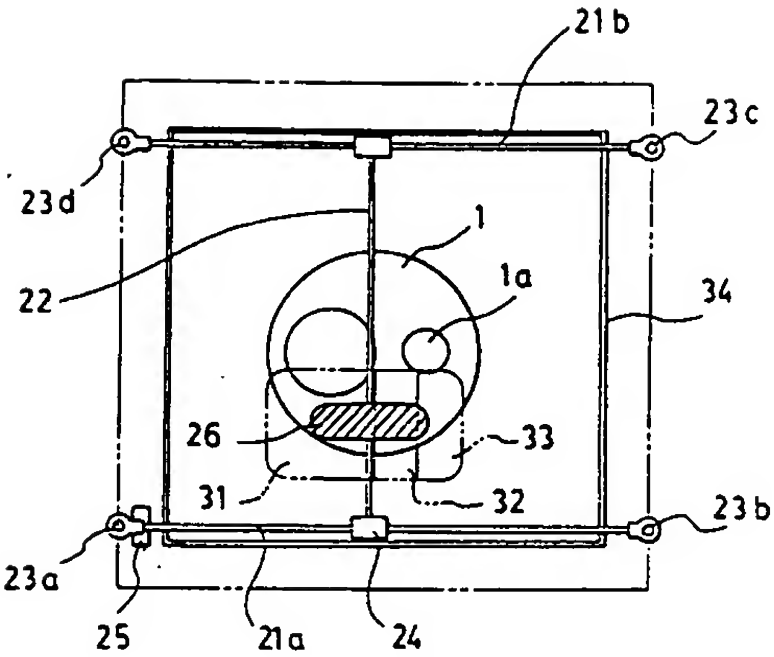
第1図



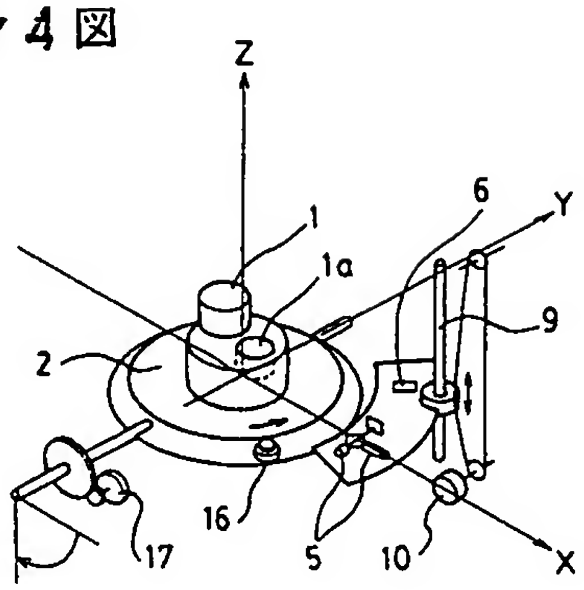
オ2図



オ3図



オ4図



オ5図